About Superluminal Propagation of an Electromagnetic Wavepacket Inside a Rectangular Waveguide

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Abstract. — We discuss the propagation of an electromagnetic wavepacket inside a rectangular waveguide, of the type employed in recent experiments on superluminal tunneling of electromagnetic signals. By exploiting the analogy between particle and photon tunneling, we consider both evanescent and growing waves inside the narrowed part of the waveguide. The Fourier expansion of such waves shows that the barrier behaves in a nonlocal way. Such a nonlocality is accounted for in an effective way by means of a deformation of the spacetime inside the waveguide. As a consequence, the wavepacket propagates at superluminal speed according to an effective metric tensor, built up in analogy with the Cauchy stress tensor in a deformable medium.

1. Introduction

In the last years, there has been a renewed interest on superluminal processes, due to some new experimental evidences in different sectors of physics. Those include, *e.g.*, the apparent superluminal expansions of galactic objects [1] and the evidence for superluminal motions in electrical and acoustical engineering [2]. However, perhaps the most interesting experimental findings are those concerning the superluminal tunneling of evanescent waves and photons [3–7], first observed at Cologne [3] and Berkeley [5], and then confirmed by a Florence [6] and a Vienna [7] group.

From the theoretical point of view, evanescent waves were predicted to be superluminal [8] on the basis of the analogy between tunneling photons and tunneling particles [9] (which, as is well known, can move with superluminal speed inside the barrier - the so-called Hartmann effect [10]). Some aspects of the superluminal propagation of electromagnetic wavepackets were discussed in references [8–15].

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